Supplier interrelationship management in project-based industries: a systematic review

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Abstract: In recent years, supplier relationship management has become the crucial yardstick for acquiring raw materials or services in project-based industries. Especially when there is a great possibility to carry out multiple projects, which requires engaging with a growing number of suppliers, managing supplier relationships is getting more important and complex. As one of the core components of supplier management, supplier interrelationship management utilizes the interrelationships among suppliers of the enterprise to generate synergistic effects that add to benefits and prevent cost overruns. However, current studies mainly focus on buyer-supplier relationship management. Supplier interaction management is still under-investigated, which hardly helps managers to build and maintain a sustainable supplier base. In this paper, we conducted a systematic literature review on the research topic of interrelationships among suppliers in project-based industries. Following a traceable literature review process, 40 relevant articles are found for the full-text content analysis. The state-of-the-art of managing supplier interactions is then explored after reading and analyzing these articles in their entirety. Lastly, the limitations of current studies and the possible actions of future research are suggested.

Keywords: Supplier interrelationship management; Project-based industries; Sustainable supplier chain; Systematic literature review.

I. INTRODUCTION

In the current global, dynamic business environment, a rising number of organizations are structured around projects to reap benefits and remain viable. It spans a variety of industries, including information technology (Wiener and Saunders, 2014), construction sector (Qazi et al., 2021), and new product development (Melander and Lakemond, 2015). With such a projectification trend, organizations must constantly manage their supplier portfolios and coordinate multiple suppliers to handle the demand for increasingly personalized services and goods. On the one hand, it is important to establish and keep a solid relationship between the company and its suppliers. Another requirement is that the organization comprehends the connections among its various suppliers and makes use of them to boost management effectiveness (Wu et al., 2010).

Over the past few decades and up to date, the connection between businesses and their suppliers has received much attention from scholars (Li et al., 2022), and several techniques and methods have been proposed to build and maintain a robust buyer-supplier relationship (Schmidt et al., 2022). However, the theories and techniques of managing interrelationships among multiple suppliers remain under-investigated, which is hard to provide managers insights into obtaining benefits by creating synergistic effects. To assess the maturity of the research issue, we intend to analyze the available literature and organize the information on supplier interrelationship management in project-based enterprises to shed some light on state-of-the-art and possible avenues of research. Consistently, this study seeks to answer the following questions:

1) What is the state-of-art of research on supplier interrelationships management in project-based enterprises?
2) What are the research gaps and possible actions related to this research topic?

The remainder of this paper is organized as follows. In the next section, we elaborate on the research background containing the standpoints and basic concepts of this study. Section III presents the literature review methodology. Section IV includes the results and discussion of the literature review and proposes an answer to the research questions. Finally, the conclusion summarizes the findings.

II. Research Background

A. Supplier interrelationship management

In the contemporary business setting, firms can no longer rely simply on their resources to sustain themselves. Instead, to secure the essential resources for making in today's fiercely competitive economy, companies always need to collaborate with suppliers (Wilhelm, 2011). Due to the intricate nature of the products and exclusivity of the business, it is essential to establish and manage partnerships with multiple suppliers simultaneously in a managed style (Levina and Su, 2008). In several industries, multisourcing has emerged as a robust outsourcing approach (Su and Levina, 2011). Management of supplier relationships is therefore crucial to an organization's sustainability.

Supplier interrelationship management refers to the relationships and interactions among the suppliers of a company. It entails taking advantage of the interrelationships among suppliers to provide competitive advantages, synergistic benefits, boost productivity, and lower risk. Compared with supplier relationship management, which is more supplier-centric and focuses on improving the relationship between buyers and specific suppliers (Li et al., 2022), supplier interrelationship management is more supply chain-centric and concentrates on improving relationships and interactions throughout the company's entire project supply chain.

Collaborating with many suppliers has certain shared benefits. First, it can assist organizations in risk management by reducing their exposure to supply chain disruptions brought on by calamities, economic downturns, or geopolitical events (Currie, 1998). Likewise, it becomes possible for organizations to react to shifting consumer and market demands more swiftly and successfully. Second, suppliers often possess specialized expertise in particular fields that might complement an organization's capabilities. Collaborating with multiple suppliers can provide access to a wide spectrum of skills, allowing them to increase the quality and originality of their products (Ivanov et al., 2019). Third, organizations are more likely to obtain competitive rates and improved terms of service through supplier competition if they have multiple suppliers (Berger, 2004). Fourth, organizations can ensure ethical and social responsibility throughout their supply chain by working with multiple suppliers who share their values and commitment to sustainability (Wang et al., 2022).

To obtain these benefits, effective supplier interrelationship management is required. Currently, a large portion of research on supplier management has focused on buyer-supplier relationships (Yang et al., 2022) without the consideration of interactions among suppliers. Only a few studies (Guo et al., 2023; Zeng et al., 2017; Wu et al., 2010; Choi and Wu, 2009) have examined the relationship between suppliers in triadic structures of buyer-supplier-supplier relationships. Despite offering guidance for firms that practice with two suppliers, the finding of these studies is hardly adequate for organizations with more than two suppliers, which is the most prevalent kind of outsourcing. There is still confusion regarding the interrelationships among different suppliers. Therefore, it is necessary to comprehend how the interrelationships among various suppliers can be utilized to produce synergistic effects and additional benefits, which can contribute to realizing strategic objectives.

B. Project-based industries

According to PMBOK 7.0, a project is a temporary endeavor undertaken to create a unique product, service, or result. Many ideas and methods have been created to direct project work and get the desired results. Project management is now a sophisticated and practical method used in many fields. Many industries organize their production and operation activities around projects, such as construction, engineering, manufacturing, aerospace, food industry, and IT, which are called project-based industries.

Project-based industries are characterized by unique challenges and complexities, including tight project deadlines, high levels of uncertainty, and diverse stakeholder requirements. In today's UVCA (uncertain, volatile, complex, and ambiguous) environment, organizations frequently rely on the collaboration and coordination of multiple suppliers to successfully deliver projects in project-based industries (Ivanov et al., 2019).

Currently, there is a growing body of research on supplier management in project-based industries. Numerous academics have studied various facets of the subject in recent years, including supplier selection (Bai et al., 2022), supplier performance evaluation (Patrucco et al., 2022), supplier risk management (Shishodia et al., 2022), and supplier development (Modi and Mabert, 2007). However, many suppliers are consistently treated as a single

entity, and the interrelationship among different suppliers is undervalued, even though project-based enterprises must deal with a proliferation of suppliers.

III. METHODOLOGY

In this work, Systematic Literature Review (SLR) approach is employed due to the rigorous and transparent characteristics it processed. The selection of an SLR aligns with the refined research field and targeted literature review questions. Moreover, this methodological approach serves to establish state-of-the-art knowledge of the subject matter and discern any research gaps. The research methodology of the work follows four steps, which are further described in Table I: (1) searching and filtering; (2) screening by keywords and abstracts reading; (3) screening by full-text reading; (4) analyzing and summarizing.

TABLE I. RESEARCH DESIGN AND STAGES FOR SLR

Phases	Processes	Outputs
Step1 Searching and filtering	***Database:*** Scopus ***Time span:*** 1967-2023(May 8) ***Screening:*** Title, author, source, keywords, abstract ***Remove if not:*** 1) Written in English; 2) Subject area: "Engineering", "Business, Management and Accounting", "Decision Sciences", "Social Sciences", "Economics, Econometrics and Finance"; 3) Document type: "Article" ***Search code:*** TITLE-ABS-KEY ((("supplier" OR "vend?r" OR "seller*" OR "purchaser" OR "provider*") W/2 ("relation*" OR "interrelation*" OR "collabroat*" OR "synerg*")) AND ("project")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (LANGUAGE , "English"))	396 items
Step2 Screening by keywords and abstracts reading	***Inclusion criteria:*** 1) Focus on interrelationships among suppliers dealing with issues in procurement management process; 2) Focus on project-based practice in enterprises. ***Exclusion criteria:*** 1) Just mention the interrelationships among suppliers, but this relationship has not been substantively studied; 2) Focus on organizational/firm level rather project level.	40 items
Step3 Screening by full-text reading		4 items
Step4 Analyzing and summariz-ing	1) Analyze the full-text available; 2) conduct Snowball method to avoid omitting highly related documents; 3) summarize results of review process; 4) organize answers to the review questions.	Results of the SLR

A. Searching and filtering

The SLR initiated a search of contributions indexed until May 8, 2023, in the Scopus database. In order to set up the search query, we initially identified the keywords associated with the research topic, which included "supply chain" "supplier portfolio" "multiple suppliers" "supplier interrelationship" "project management" and "project-based firm". Second, the phrases "vendor" "seller" "provider" "purchaser" "synergy" and "collaboration" were also included as synonyms for the keywords. Following some search trials using these terms, the search code was defined by excluding some of the results that were too narrow. In the end, 396 articles were identified through this search query.

B. Screening by keywords and abstracts reading

In this step, the inclusion and exclusion criteria are defined based on the research topic, shown in Table I. By carefully examining the title, keywords, and abstracts, all irrelevant papers were eliminated. Forty papers were produced as a result of this step for the full-text content analysis.

C. Screening by full-text reading

The whole text of each article was examined at this stage to determine whether the research adhered to the review's purpose. The inclusion and exclusion criteria are the same in step 2. Also, the core information and reason for exclusion were noted. Among 40 articles, 36 were excluded. Table II displays the final list of papers included for later analysis.

TABLE II. FINAL LISTS OF PAPERS

Title	Journal	Year
Managing innovation in regional supply networks: a Dutch case of "knowledge industry clustering"	*Supply Chain Management: An International Journal*	2003
Forced coopetition in IT multisourcing	*Journal of Strategic Information Systems*	2014
Toward robust concurrent product development across the supply chain: a risk assessment framework	*Journal of Engineering Design*	2020
Managing triadic supplier relationships in collaborative innovation projects: a relational view perspective	*Supply Chain Management: An International Journal*	2022

D. Analyzing and summarizing

In this stage, the full text of the four articles was read and analyzed with the assessment of their quality and relevance. In order to prevent omitting highly relevant documents that might have been

overlooked during the initial searching stage, the Snowball method was conducted to focus on the references and cited papers in the final list. After that, we summarized the results of the review process and organized the answers to the review questions proposed in the Introduction, which involves synthesizing the findings and presenting them in a clear and concise manner.

IV. RESULTS AND DISCUSSIONS

After a step-by-step review, four articles that were closely related to our investigation topic were left. This section gives an overview of the findings from the four publications' analysis and snowball study. Then, some findings are derived by reflecting the whole SLR process based on the records of screening and filtering. In light of these, we discuss the implications and highlight some areas where future research is needed.

A. Summary of reviewed papers

Starting with the earliest paper on the final list, Batenburg and Rutten (2003) conducted a case study on the collaboration between a printer manufacturing company and its lead suppliers at a project level. They analyzed how this manufacturing firm initiated and managed a prominent project to create synergy through collaboration between its suppliers. According to the case study, when a group of suppliers was brought to work together with members with different specializations and professional backgrounds, one of the suppliers would become the "lead partner." With the lead role, the suppliers are responsible for the project and coordinating activities among different partners, including activities between a firm and its suppliers and among multiple suppliers. From this study, it can be inferred that one of the key success determinants is mutual trust among suppliers. In contrast to the qualitative case study of the manufacturing industry, Esterman et al. (2020) proposed a risk assessment framework for manufacturing organizations. This framework allows risks to be assessed from supplier interactions, intra-supplier, inter-supplier and inter-projects. Additionally, it enabled metrics developed to measure risk within a particular supplier to be aggregated to assess risks between suppliers, which can help practitioners and managers with product design decisions.

The other two papers are about the IT industry. Wiener and Saunders (2014) introduced a new form of cooperation named "forced coopetition" to characterize the relationships among suppliers in IT industries. In the last two decades, multi-sourcing in the IT industry has grown strikingly. However, the overlap in supplier skills and areas would inevitably lead to intense competition among suppliers, thereby influencing the corporation. The concept of forced coopetition is proposed to help manage the delicate balance between competition and cooperation among suppliers. Similarly, Patrucco et al. (2022) focused on collaborative innovation projects with their triadic supplier relationships. They adopted multiple case studies and interview data to discuss the structural and relational features of four archetypes of triadic relationships. In this paper, the supplier-supplier relationship has been termed "coopetition." They held the same opinion that only a careful balance between competition and collaboration among suppliers could ultimately achieve project success, which can be found in supplier relationship management at a firm level (Potter and Wilhelm, 2020).

Regarding the results of the snowball method of the four papers, it was found that the work of Batenburg and Rutten (2003) and Esterman et al. (2019) did not yield relevant literature, while a few articles in the references and cited paper of the other two (Wiener and Saunders, 2014; Patrucco et al., 2022) were found. These studies hold a mutual point of view that besides managing the relationship with its suppliers, a buyer needs to manage the relationships among those suppliers proactively (Wu et al., 2010). Most of the discussions are in the context of triadic relationships, buyer-supplier-supplier relationships (Guo et al., 2023; Zeng et al., 2017; Wu et al., 2010; Choi and Wu, 2009). It means they mainly analyzed the interrelationship between two suppliers and didn't involve multiple suppliers. The complexity and dynamics of managing relationships among suppliers would only be partially understood. Additionally, these studies do focus on the interrelationships among multiple suppliers, particularly with the topic of multisourcing (Levina and Su, 2008) and supplier-supplier relationships (Guo et al., 2023; Wu et al., 2010; Ried et al., 2021). However, they are always analyzed at a firm or industry level without consideration of project-specific characteristics. The results and insights gained from these studies may not be relevant for project managers dealing with the complexities of managing multiple suppliers within a specific project context. Project managers may need to rely on their own

experiences and intuition rather than empirical evidence from the studies, potentially leading to less effective decision-making and project outcomes.

B. Summary of SLR process

Although there are only a few studies related to supplier interrelationship management in project-based industries, we examined the abstracts of 396 publications. We also recorded the reasons for excluding each one in every step of the proposed SLR process. Based on the analysis of the records, some findings were summarized, which can provide us with insights into the state-of-art of the research topic.

First, it was found that little research paid significant attention to the relationships among different providers, with most studies concentrating on the interaction between buyers and suppliers. Although some studies did mention the relationships among suppliers, none of them explicitly studied them. And among the studies considering the relationship between suppliers, there are no more suppliers than two, which is about the triadic relationship. Another finding from reflecting on the SLR process was that many studies treated multiple suppliers as a homogenous group when conducting management in other knowledge areas, such as risk management, cost management etc. It fails to consider the unique characteristics of individual suppliers, the interrelationship among them, and their contributions to the project. In addition, it was found that most excluded studies focused on the enterprise or industry level rather than the project level. It indicates a need for more research that specifically explores the intricacies of managing supplier interrelationships in a project context. Project-level research could help shed light on how the unique features of each project affect supplier relationship management and provide more practical guidance for project managers. Lastly, in terms of research fields, we found from the SLR process that most of the studies on supplier relationship management were concentrated on construction and infrastructure, while the highly related papers are about the IT and manufacturing industry. They treated a specific process, for example, product development, as a project to explore the relationships among suppliers. This finding suggests opportunities for a broader understanding of supplier relationship management across different industries. Overall, the information is valuable for understanding the limitations of current research and identifying opportunities for future studies.

C. Research gaps and possible future actions

Based on the findings derived from the reviewed papers and the reflection of our SLR process, there are several research gaps in supplier interrelationship management in project-based industries. The absence of studies that take into account the unique project-specific characteristics in supplier interrelationship management is a significant research gap. It implies that more research is needed to explore how supplier interrelationship management can be tailored to meet the specific needs of project-based industries. Additionally, there is a need for more studies that explore the interrelationships between multiple suppliers. The current studies primarily focus on the relationship between buyers and suppliers, with little attention given to how suppliers interact with each other. Future research could be deployed in the following ways to fill these gaps.

1) *Defining the nature of interrelationships among suppliers in project-based industries.* While the significance of relationships among suppliers has been ascertained, the nature and characteristics of these relationships are still unclear, especially in a project context, which can be a promising area for future research. Possible actions could take into account the unique features of project-based industries. This includes the specific characteristics of projects, such as project scope, objectives, timelines, and the one-off nature. By incorporating these factors into research, a more comprehensive understanding of supplier interrelationship management can be achieved. It can also involve investigating the categorization or dynamics of interrelationships among suppliers, such as how they are formed, maintained, and changed over time, as well as the factors that facilitate or hinder effective collaboration among multiple suppliers.

2) *Examining the impact of interrelationships among suppliers on project procurement.* It involves evaluating the degree of cooperation and collaboration among suppliers, the extent to which suppliers are dependent on each other, and the role of trust or communication in these interrelationships. It also involves examining how these interrelationships affect procurement outcomes, including project performance, cost, quality, and risk management.

3) *Utilizing interrelationships among multiple suppliers to enhance project procurement process.* Possible research directions include investigating

how firms can strategically select supplier base with the consideration of supplier interrelationships and manage it to achieve specific project goals, as well as examining the role of supplier networks and alliances in facilitating effective project procurement management. Moreover, future research can explore the role of technology and digital platforms in facilitating supplier collaboration and communication in project-based industries.

Overall, these implications and recommendations highlight the importance of understanding supplier interrelationship management in project-based industries and the need for more comprehensive and contextualized research to advance our knowledge of this area.

V. CONCLUSION

This study conducted a step-by-step SLR in the context of supplier interrelationship management in project-based industries to answer the research questions. RQ1: what is the state-of-art research on supplier interrelationships management in project-based enterprises? RQ2: what are the research gaps and possible actions related to this research topic? From the presented results and discussions, three conclusions regarding the state-of-the-art emerge to answer RQ1:

a) Research on interrelationships among more than two suppliers is still in its infancy, and existing studies merely note the significance without going into depth.

b) In the realm of research on supply chain relationships in project-based industries, the majority of studies have mostly focused on buyer-supplier relationships. In contrast, the relationships among suppliers themselves have been overlooked.

c) The research in this area has primarily concentrated on the construction and infrastructure sector, followed by the manufacturing and IT industry.

Next, two research gaps have been identified. The first research gap is the lack of studies considering the unique project-specific characteristics in supplier interrelationship management. The second is focusing only on the relationships between buyers and suppliers while being unaware of the interrelationships among suppliers. These gaps lead to the following three topics about possible research actions: 1) defining the nature of interrelationships among suppliers in project-based industries; 2) examining the impact of interrelationships among suppliers on project procurement; 3) utilizing interrelationships among multiple suppliers to enhance project procurement process.

In conclusion, this literature review paper has contributed to the understanding of supplier interrelationships management in project-based enterprises by summarizing the current state-of-the-art and identifying research gaps. The proposed future research directions provide insights for scholars and practitioners in the field of project procurement. Despite the aforementioned contributions of this study, any literature review process presents an element of subjectivity, which may potentially lead to bias in the selection of reviewed materials. To further advance this research area, future studies could consider conducting empirical research, employing quantitative or qualitative methods, to validate and expand upon the findings of this literature paper.

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